THE PARTICULARS OF TERRITORIAL DISTRIBUTION AND ANTHROPOGENIC RIVER RUNOFF VARIATIONS FOR THE MOUNTAINOUS AREA OF CENTRAL ASIA

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Spatial distribution of runoff values for the rivers of Central Asia depends on elevation and orientation of the locality, and extension of mountain systems.

Jime variations of runoff in the second half of the 20th century depend on the relationship between feeders. As for anthropogenic factors, irrigated farming affects runoff most of all. The influence of basins is determined by their size and latitudinal position.

Consideration is given to the particulars and general regularities in the spatial distribution of annual mean, maximal, and minimal runoff over the Altai and Sayan Mountains, Tian Shan, and the Pamirs. It has been established, with the help of complex geographical and hydrological studies, that the distribution of water balance elements and values of the rivers' runoff depend on elevation and orientation of the locality and the extent of the mountain systems. The size orientation and annual mean runoff of similar in basin areas (from 3,000 to 6,000sq.km.) and the mean elevations of basins (2,000-2,500m) are given in Table 1.

Complex statistical calculations of observation data for 100, 60, and 35-year periods suggest that, in the second half of the 20th century, negative variations prevail in the annual mean runoff over Central Asia. But, in rivers substantially fed by glaciers (more than 20%) and in snowmelt- and rainfed rivers in the outlying and northwestern areas of Altai, Sayan, Dzungarian

Ala Tau, the Pamirs, and Alai, positive variations are observed in annual runoff as well as runoff for flood and low-water periods.

In Fig.1, long-term smoothed runoff is shown for glacier- and snowmelt-fed rivers in the mountains of the Central Tian Shan area (r.Bolshoi Naryn) with a negative trend from April to September and positive runoff trends for the peripheral regions of Western Tienshan (r.Maidantal), Western Pamir, and Altai (r.Bartang, Zungar, Pasrut). The differences account for the amount of precipitation and icing.

Among the numerous kinds of domestic activity, the rivers' runoff over the Central Asia mountains is most affected by irrigated farming agriculture. Using the test method for trend, it was established that climate variations and increase of water loss during the irrigation period in the northern Tian Shan, Pamirs, and Altai areas resulted in a decrease in the annual mean runoff for the period from 1951 to 1990, which amounted to 0.04-0.06l/s for 1sq.km. per year. It was particularly great in the upper drift of the mountain rivers where filtration has sharply increased at the cost of irrigation, and a decrease in loss from evaporation and, sometimes, even a rise in runoff can be observed.

Water loss on evaporation from the water storage basin is determined by the size, latitudinal position, elevation, and orography of the place.

For example, the loss from the Chimkurgan reservoir on the Kashkadarya River(southwest of Central Asia) decreased the river runoff by 29%, and the loss from the Krasnoyarsk reservoir on the Yenisei River (north of Central Asia), only by 8%.

The total river runoff loss is so great on the rivers Amu-Darya and Syr-Darya (Fig.2) that it has worsened the ecological conditions of the Aral Sea and Lake Balkhash.

If some trend is detected in the runoff variations of high significance (more than 95% probability), the values of calculated runoff norms should be corrected according to the following formula.

$$q_{i\delta} \equiv \bar{q} \pm nq \,,$$

where

$q_{i\delta}$ = predetermined normal runoff,

$\bar{q}$ = normal runoff, calculated for the previous long-term period, n = period duration, and

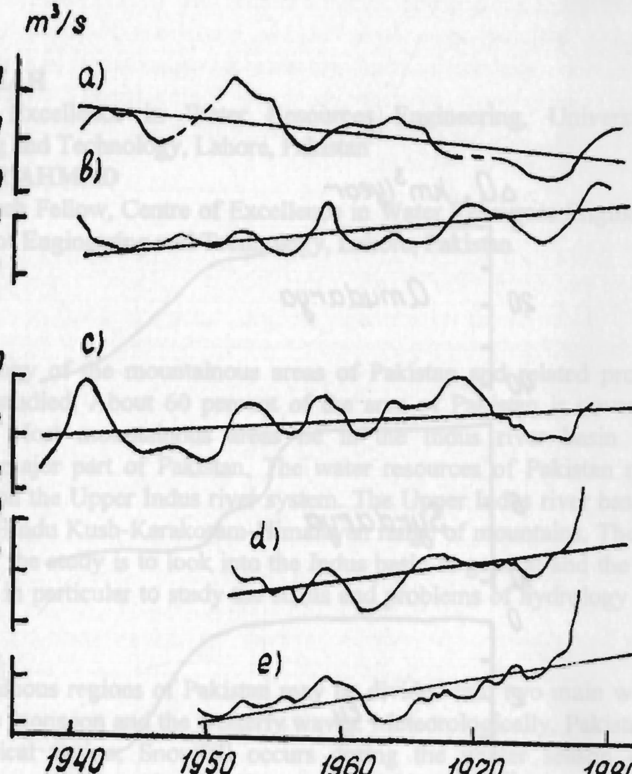
q = magnitude of the normal runoff variation (for a year) under the impact of climatic or anthropogenic factors.

Steady runoff variations and climate variations allow for prognosis of the amount of water resources at the beginning of the 21st century.

Table 1

River basin	Coordinates N	Coordinates W	General orientation	Module of annual mean runoff, l/s for 1 sq. km
		Dzungarien Ala Tau		
Caratal	45	78-80	west	15.2
Tentek, Lepsy	46	80-81	north	11.5
Usek, Khorgos	44	80-81	south	4.0
		Altai and Mongolian Altai		
Ulyba, Uba	51	82-84	south-west	52.0
Cobdo	49	88-90	south-west	1.10
		Sayany-Khangai		
Maly Yenisei	51	98-100	west	2.80
Ider	49	97-99	north-west	2.50
Ongi	47	103-104	south-east	0.35

Figure 1. Smoothed long-term runoff for glacier- and snowmelt-fed rivers for April to September



a - r. Bolshoi Naryn - outlet;
b - r. Maidantal - outlet;
c - r. Pasrut - Pinnon;
d - r. Bartang - Jindzhang;
e - r. Jyngar - outlet.

Figure 2: River runoff variations under the impact of economic activity of human beings